Annals of Physical Medicine

The official organ of the
BRITISH ASSOCIATION OF PHYSICAL MEDICINE

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THE PRESIDENT

[From the Portrait Gallery by Douglas Glass in *The Sunday Times*]

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FOREWORD

ALTHOUGH I feel that some apology is needed for the very conspicuous character of the photograph opposite, that is not my business. I do *not* apologize for this brief foreword by which to welcome and introduce the ANNALS OF PHYSICAL MEDICINE.

These Annals will record the work of our Association, a body which was formed nine years ago " to encourage the study of the action of physical agents and their application in the promotion of Health; in the prevention and treatment of illness and injury; and in the restoration to fitness ".

Our brief is a wide one. It starts with keeping people fit and with making nearly fit people quite fit. Bearing in mind our British temperament, and thus excluding formality in physical exercise, it might even be possible to revive the Greek ideal of what Brigadier Howitt once called the " cultured-citizen-athlete ".

Then our brief includes control of the whole range of those physical measures which conveniently go by the name of Physiotherapy. We take the Spas and Health Resorts in our stride. We are concerned with the correction of deformities, congenital and acquired; and the application of physical methods to the treatment of the chronic rheumatic diseases.

Research and education will continue to occupy our attention. Our purpose is to improve the status of the Physical Medicine Specialist and to stimulate the Universities in the direction of increased prestige for this important branch of Medicine.

I have taken this opportunity of summarizing the meaning and activities of the Association which these Annals will strive faithfully to record.

I am honoured by the invitation of my colleagues to write these few words of good will and good cheer.

HORDER.

EDITORIAL

THE last three decades have witnessed a change in the whole concept of physical medicine. Its scope has expanded to include physical education, rehabilitation and re-settlement, in addition to the use of physical agents in diagnosis and treatment. The diseases and disease groups for which physical methods are now routinely prescribed have multiplied. Finally, the specialty has established itself as a clinical branch of medicine.

Let us compare the situation with that which obtained 25 years ago. There were at that time at Kings, the London and a handful of other hospitals, departments which anticipated those which now exist. There were also men of the calibre of Turrell, Lewis-Jones and J. B. Mennell, who made considerable contributions in their particular fields. By and large, however, the picture was not encouraging. The specialty, if indeed it could be regarded as a specialty, was then known as physiotherapy. The technicians were called masseuses, and the departments more often than not were managed by the senior masseuse under the titular direction of a radiologist or dermatologist who was often little exercised by what happened in the department. Treatment was passive, palliative and to a great extent empirical, and the main bulk of patients attending the departments were chronic sufferers from diseases of the locomotor system, for whom little could be done in other departments of the hospital. It was a sign of the times that a patient when asked what was wrong with him, replied " Radiant Heat to the back for twelve years."

Side by side with the clinical advances outlined above there have been developments in other aspects of the subject. In April, 1931, the Physical Medicine Group of the British Medical Association was established. In 1932 the Sections of Balneology and Electro-therapy (less the Radiologists) fused to form the Physical Medicine Section of the Royal Society of Medicine. In 1943 the British Association of Physical Medicine was founded. In the same year the first examination for the Diploma was held.

The latest development is the decision of the British Association of Physical Medicine to publish its own quarterly journal. This is not a responsibility to be regarded lightly when the relatively small number of members, together with their heavy commitments, is taken into account. There can be no doubt, however, that there is a vast field for clinical and technical research in Physical Medicine, and that the official journal of the Association is a proper place in which to record these researches.

Two things should be realized from the outset: first, the success of the journal will depend on the contributions of Members of the Association, and second, the clinical status of the specialty will be judged on the standard of these contributions.

FURTHER INVESTIGATIONS INTO THE EFFECTS OF MICRO-WAVES

By A. C. BOYLE, H. F. COOK and D. L. WOOLF
From the Middlesex Hospital, London

WITH the development of the multi-cavity magnetron and its employment in radar in the recent World War, a new therapeutic agent in medicine became a possibility. The production of radio waves with a free space wavelength below 30 cm. (micro-waves) has partially spanned the gap between diathermy and infra-red rays, and a preliminary investigation into the effects of these radiations, together with a brief history of their development, has been the subject of a previous paper (Boyle *et al.*, 1950).

The object of the present paper is to describe the results of further experimental work, the subject matter being mainly physical in character, since this is an essential preliminary to clinical application. It is hoped to report on the latter in a future paper.

In our previous report, all experimental work was carried out with pulsed radiations, but as a continuous-wave set has more recently become available, results with this type of apparatus have been included in the experiments to be described. We have not so far been able to demonstrate any effect of micro-waves other than a thermal one upon living tissues, nor does there seem to be conclusive evidence in the published literature to dispute this. We believe this to be of great importance, since the practice of physiotherapy has tended in the past towards the employment of elaborate and often expensive apparatus for which extravagant claims have been made, and without due regard to the fact that simpler and cheaper measures might bring about the same therapeutic aim.

In the evaluation of new apparatus, clear advantages over satisfactory existing methods are of importance, and since a thermal effect has been the only one so far demonstrated, the heating pattern, penetration, distribution of heat in the tissues, and facility of application are among the factors which must be carefully weighed against such well-known methods as diathermy and infra-red irradiation. It is with this thought in mind that we have continued our investigations.

Improvements in Apparatus and Technique

(*a*) *Micro-wave apparatus and calibration*

Preliminary investigations (Boyle *et al.*, 1950) on the effects of micro-waves were carried out using 10 cm. pulsed micro-waves from a powerful radar set. The obvious unsuitability of this arrangement for further

work (particularly that of a clinical nature) led to the construction of a portable continuous-wave set. A suitable magnetron valve (9·4 cm. wavelength), its power pack and accessory wave-guide apparatus, were mounted in a converted theatre trolley. This also carried a Variac control for high tension, a milliammeter for measurement of magnetron current, and a microammeter providing, by suitable arrangements, a measure of the standing wave in the short wave-guide section into which the magnetron was coupled.

From the trolley, micro-wave power was fed out of the wave-guide, via several feet of coaxial cable, to interchangeable wave-guide applicators mounted on an adjustable stand (Plate I). Two wave-guide applicators were constructed. One was a rectangular wave-guide flare providing an aperture 7·6 cm. × 7·0 cm.; the other was a cylindrical wave-guide with two interchangeable diaphragms of diameter 7·0 cm. and 3·2 cm. The apertures were filled with either cork or perspex, providing the smooth surfaces required when micro-wave applicators are used in contact with the skin. In the case of the cylindrical applicator, impedance matching into tissues was improved by the inclusion of lead glass discs of total thickness equal to one quarter wavelength.

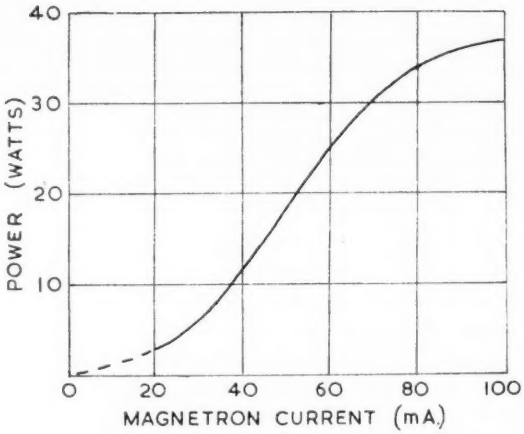

FIG. 1.
Calibration curve showing variation of power entering skin with magnetron current (7·6 cm. × 7·0 cm. rectangular applicator; skin contact).

The magnetron current was found to provide a reliable measure of the micro-wave power entering the skin surface when in contact with the applicators. Fig. 1 shows a typical calibration curve for the apparatus, providing a reasonably accurate dosage estimate. When irradiation is carried out under non-contact conditions (e.g. with a few cms. air gap),

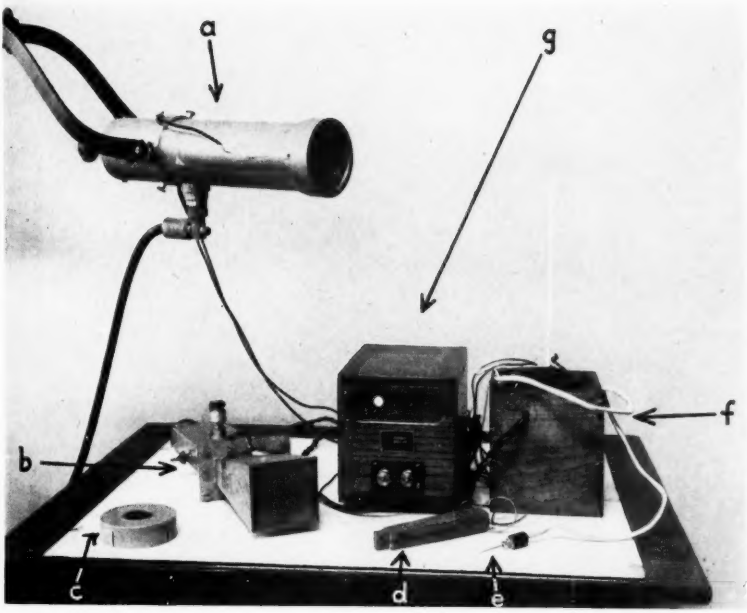

PLATE I.

Wave-guide applicator and thermometry apparatus.

(*a*) Cylindrical wave-guide fed by cable from continuous-wave magnetron. 7·0 cm. diameter aperture.
(*b*) Interchangeable rectangular wave-guide applicator. 7·6 cm. × 7·0 cm. aperture.
(*c*) Diaphragm for (*a*) 3·2 cm. diameter.
(*d*) Thermojunction mounted on cork handle.
(*e*) Thermojunction mounted in hypodermic needle.
(*f*) Box containing reference junctions, switch, etc.
(*g*) Galvanometer.

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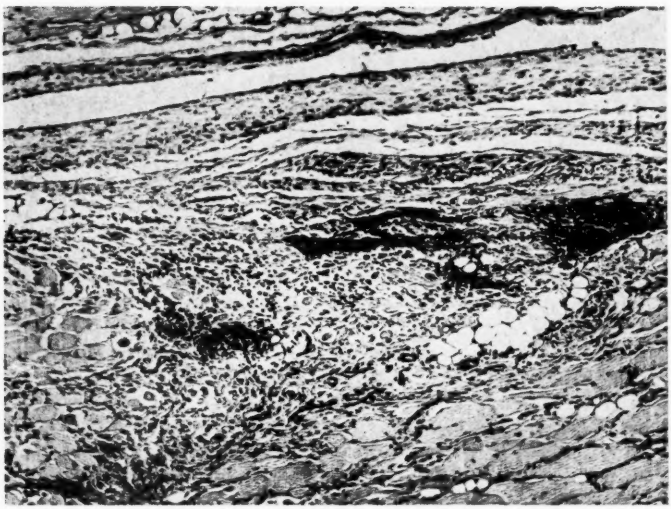

PLATE II.

Section of muscle of rabbit's thigh following irradiation over metal plate, showing inflammatory degeneration and coagulation necrosis (normal muscle in the right lower quadrant).

no reliable measure can be made of the actual power entering the skin, a disadvantage of this method as compared with the contact method.

Following the established practice in radiotherapy of representing a beam of radiation passing into tissues by iso-dose curves a similar representation of micro-wave beams by iso-power curves is of value. Relative power measurements made in a saline phantom have enabled the iso-power curves shown in Fig. 2 to be obtained. The concentration and temperature of the salt solution were adjusted to make the phantom equivalent in absorbing properties to human muscle. Such curves show

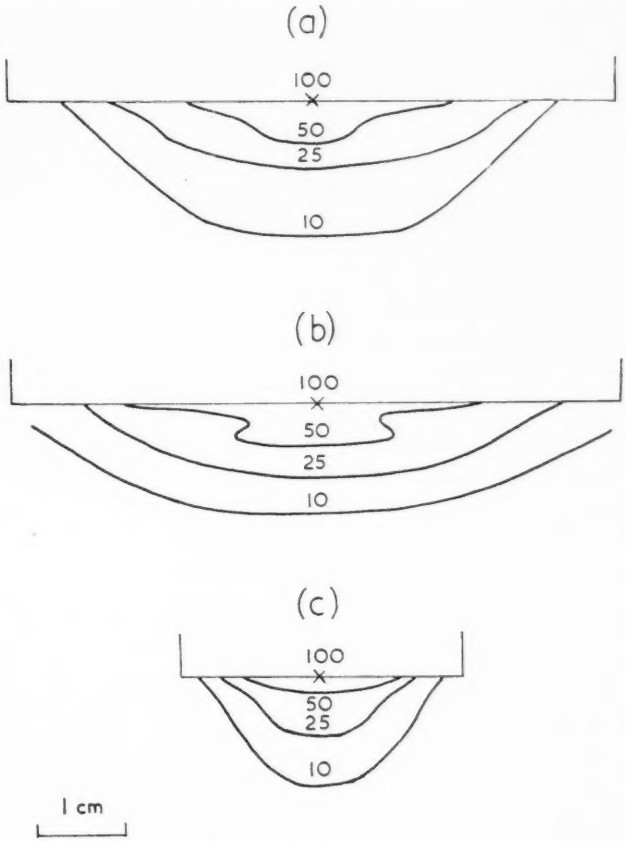

FIG. 2.

Percentage iso-power curves from measurements in the central plane of a beam passing into a saline solution equivalent to muscle in absorption.

(*a*) 7·0 cm. circular aperture in contact with phantom.
(*b*) 7·0 cm. circular aperture at 2 cm. distance from phantom surface.
(*c*) 3·2 cm. circular aperture in contact with phantom.

clearly the radiation distribution to be expected in tissues, but it must be emphasized that the power distribution in the practical case differs from that shown in Fig. 2 depending on the thickness of adipose tissue, bone, etc., which may be present.

(*b*) *Thermometry*

In early work with animals and humans, skin temperatures were measured after exposure by means of a thermistor and bridge. A big advance was made when it was found possible accurately to measure skin temperatures during irradiation. This was achieved by the use of a fine wire thermojunction permanently attached to each micro-wave applicator. Stretched across the applicator aperture, in the direction perpendicular to the electric field, no field pick-up effects in the wires were observed. The junction (normally at the centre of the aperture) then provided a measure of the temperature of irradiated tissues in contact with the aperture. The thermojunction leads were connected in series with a galvanometer and reference junction (see Plate I).

Suitable switching arrangements were made to allow for the use of two other thermojunctions, (*a*) one carried in a 22 gauge hypodermic needle and (*b*) one mounted on a cork holder. They were used for tissue and skin temperature measurements before or after exposure. The disturbing effect on the micro-wave field distribution of a steel hypodermic needle has prevented its use for measurement of tissue temperature during exposure.

The above experimental arrangement for measuring skin temperatures during exposure can be modified to a form suitable for routine clinical use. The temperature measuring equipment can be fitted into the magnetron trolley and thus provide continuous monitoring of skin temperature during treatment.

The Absorption of Micro-waves in Tissues

Investigations of the dielectric properties of various types of human tissues at micro-wave frequencies have provided important information regarding the physical processes involved when micro-wave energy is absorbed by tissues, and the different absorbing properties of various tissues. England (1950), and Cook (1951*a*) have reported results of micro-wave dielectric measurements on fresh specimens of human tissues such as skin, muscle, adipose tissue and bone. Cook (1951*a*) has analysed the results and shown how micro-wave absorption by tissues depends on the radiation wavelength, and on the ionic conductivity and water concentration in the tissues. Both intra-cellular and extra-cellular water and ions contribute to the absorption.

Studies of micro-wave propagation in the human body are greatly assisted by a knowledge of the energy absorption coefficients of different

tissues and the coefficients of reflection at tissue layer interfaces (e.g. skin-fat, fat-muscle). These coefficients (for plane wave propagation) have been obtained as a result of the dielectric measurements referred to above.

An alternative to the absorption coefficient to describe tissue absorption is the half-power-thickness, i.e. the thickness of tissue required to reduce the incident power to half its value. Table I gives these thicknesses for different wavelengths of radiation and for four types of human tissues.

TABLE I.

HALF-POWER-THICKNESSES IN MM. OF VARIOUS TISSUES.

	Radiation wavelength (cm.).					
Type of tissue	1	3	5	10	20	30
Skin	0·3	1·1	2·6	5·4	7·5	8·5
Muscle	0·25	1·0	2·1	4·5	6·5	7·2
Average adipose tissue	—	—	4·3	17·3	24·7	—
Bone	—	—	9·1	24·7	34·6	—

The figures demonstrate the relatively low absorption in fatty tissue and bone as compared with that of skin and muscle. The latter two types of tissues have little difference in their absorbing properties. The rapid decrease in half-power-thickness as the wavelength decreases is due entirely to the dependence on wavelength of the absorbing properties of the water content of the tissues.

The reflection coefficients of tissue interfaces are determined by the dielectric properties of the tissues concerned. Cook (1951*a*) has published values of these coefficients for radiation of different wavelengths. The influence of interface reflections on micro-wave propagation in the superficial tissues of the human body will be referred to in the next section.

Analysis and Discussion of Temperature Rises Observed in Human Tissues Exposed to Micro-waves of 9·4 cm. and 10 cm. Wavelengths

(*a*) *Skin temperature rises*

Results during exposure, obtained by the method described above, have already been published by Cook (1951*b*) together with their thermal analysis. The initial rate at which the skin temperature rises during exposure depends mainly on the power density of the radiation and the thermal conductivity of the tissues. A sensation of burning pain is obtained with power densities entering the skin greater than about 0·8

watts cm.$^{-2}$, the exposure time required for this sensation to be felt decreasing as the power density increases above this level (Cook 1951*c*).

With power densities below this critical value, enhanced blood flow and vasodilatation due to heating enable the skin temperature to be maintained at an approximately constant value below the painful level (45-47° C.), the temperature rise above normal being proportional to the power density.

Fig. 3 gives one example of results obtained for the forearm with and without occlusion of the blood supply. The observed rate of temperature rise above normal with ischaemia agrees well with the theoretical rate if the

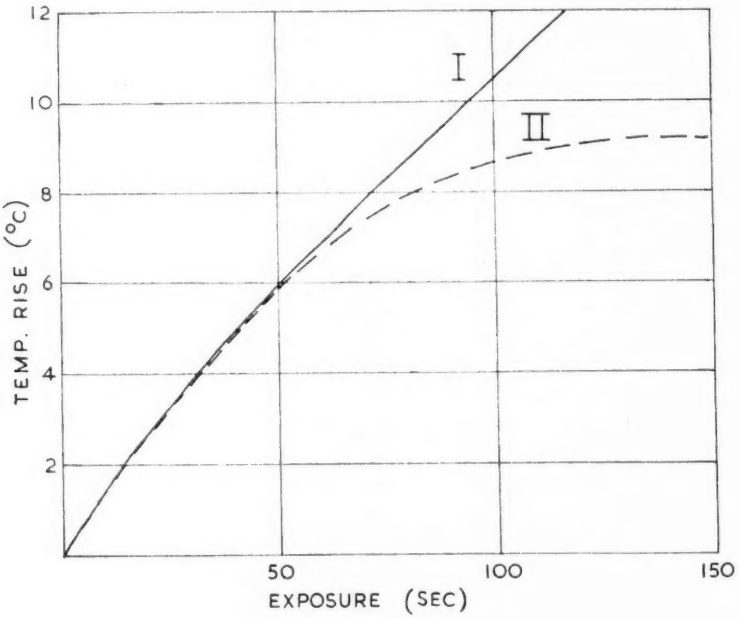

FIG. 3.
Skin temperature rise with 0·5 watts per sq. cm. entering skin of forearm (central point of 7·6 × 7·0 cm. field; 10 cm. wavelength).
Curve I—ischaemia.
Curve II—normal.

thermal conductivity of the tissues is 5×10^{-3} cal. cm.$^{-1}$ sec.$^{-1}$ °C.$^{-1}$. In the normal case, the initial rate of rise corresponds to this conductivity, but after from 30 to 60 seconds exposure the effective conductivity rises rapidly to very high values until equilibrium is maintained between heat in-put and dissipation. Comparison of the two results shows the effect of blood supply on skin temperatures during exposure.

(*b*) *Tissue temperature rises*

The temperature at various depths along the central axis of an irradiated block of tissues has been investigated immediately after exposure. Most of these experiments have been done on the thigh and specimen results already published (Boyle *et al.*, 1950). An analysis of the results in terms of heat conduction theory has appeared elsewhere (Cook, 1951*b*).

Although the iso-power curves of Fig. 2 give a true picture of energy absorption in homogeneous muscle, they provide little guidance to the isotherms existing in irradiated tissues. Thus Fig. 2 indicates that a large proportion of the energy in the micro-wave beam is absorbed in the first centimetre of tissue. Yet, during exposure, temperatures at depths of 4 cm. or more continue to rise steadily. The effect (which occurs with all thermogenic radiations) demonstrates the marked influence of physical and physiological processes in transferring heat from the main absorbing region near the surface to regions of greater depth. As a consequence the temperature gradient is much less steep than would be expected from consideration of the distribution of absorbed energy alone.

A feature of all experimental results on humans is the effect of a layer of adipose tissue interposed between skin and muscle in producing a trough in the curve of temperature against depth. The shape of this curve can be correlated with the combined effect of multiple reflection at tissue interfaces and the lower absorption in fatty tissue as compared with skin and muscle. Full details of the way in which this correlation is obtained will appear elsewhere. Briefly, it involves the calculation of the variation of field strength with depth, followed by the use of the known absorption coefficients to derive the relative distribution of absorbed energy with depth. Finally, the approximate variation of temperature with depth can be deduced.

The thickness of the fatty layer has a large effect, illustrated in Fig. 4. The shaded areas show the way in which the energy absorbed is distributed, while the temperature curves show approximately the temperature distribution after about three minutes exposure at a tolerable power level. The temperature trough in the fatty layer remains relatively constant for longer exposures, while in muscle the temperature peak broadens and moves to lower depths as the exposure proceeds. The magnitude and depth of this peak depends also on the thickness of the fatty tissues.

Up to the present time all experiments have shown that the highest subcutaneous temperature achieved is always below that of the skin when various anatomical regions have been exposed to micro-waves (9 to 10 cm. wavelength) in contact with wave-guide applicators.

No experiments on humans have yet been performed in regions where bone lies near the skin. The low absorption by bone indicates that its effect on temperature distribution should be similar to that of fatty tissue.

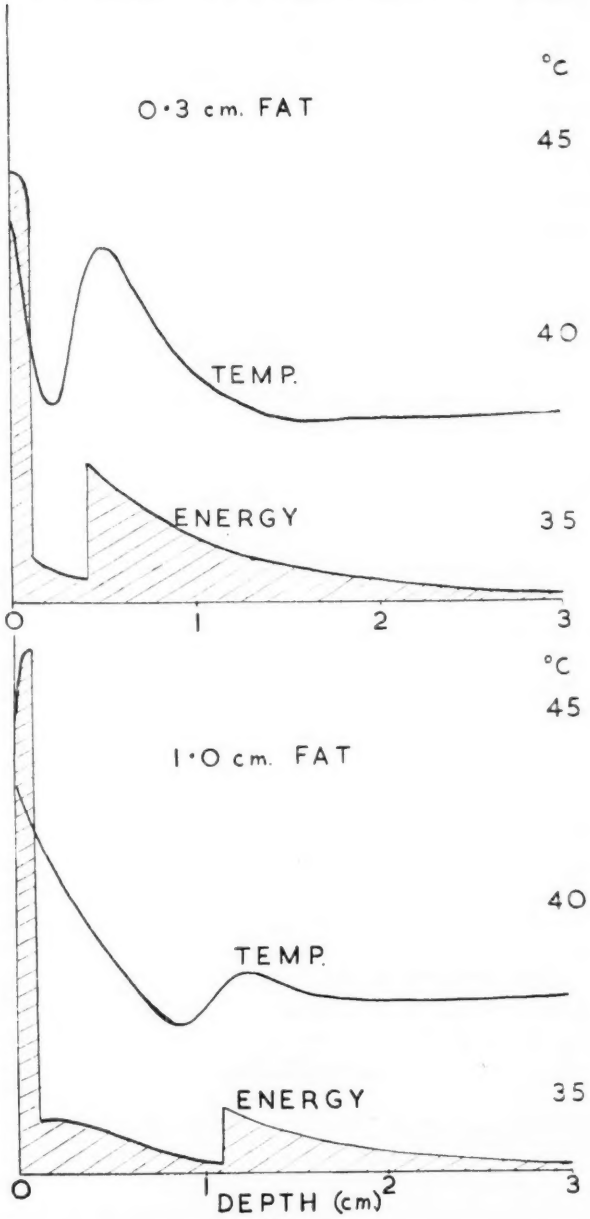

FIG. 4.
Calculated central axis distribution of absorbed energy and variation of temperature with depth, showing influence of fatty tissue thickness (for 3 mins. exposure; 10 cm. wavelength).

Comparison of the Contact Method of Micro-wave Application with the American Method

Workers in the U.S.A. have favoured the use of a micro-wave reflector or director mounted at a distance of 2·5 to 5 cm. from the skin. Under these conditions heat is lost from the exposed area to the air by radiation, convection and evaporation. In our method a negligible proportion of the heat produced in tissues is lost to the applicator material. It will be of value briefly to note the advantages and disadvantages of each method.

(*a*) When vigorous cooling to the air takes place the skin temperature achieved during exposure may be lower than the temperatures reached in the underlying tissues. In the contact method the opposite obtains. Thus the dangers of producing coagulation necrosis at a depth without pain or damage to the skin are quite real when air cooling is present.

(*b*) With contact applicators all the transmitted energy can be utilized, and, more important, it can be measured. With the other method only an approximate estimate of absorbed energy can be made.

(*c*) Skin temperatures can be measured continuously during exposure when contact applicators are used.

(*d*) The contact method has the disadvantage that unless contact is maintained a spurious skin temperature is recorded.

(*e*) A further disadvantage of the contact type of applicator arises when inflammatory areas are irradiated. The mechanical contact causes discomfort to the patient.

On balance, we prefer the contact method, though a final decision will not be made until much more clinical experience has been accumulated. The type of applicator described in this paper can, of course, be used for either irradiation method.

Comparison of 10 cm. Micro-waves with other Thermogenic Radiations

(*a*) *Micro-waves of other wavelengths*

The variation of tissue absorption with wavelength is shown in Table I. We have made no experimental comparison of temperatures achieved in human tissues by micro-waves of greatly differing wavelengths, but some conclusions can be drawn from the half-power-thicknesses shown in the table.

It is safe to assume that differences in deep heating will not be so marked as the differences in absorption at various wavelengths. If greater penetration of radiation is the criterion then the longest wavelengths should be advantageous. On the other hand, applicator sizes would then have to be increased to cumbersome proportions. Since deep-heating is mainly due to heat transfer from more superficial absorbing regions there seems to be little advantage in increasing the wavelength

above the region of 10 cm. To go much below this wavelength region would result in bigger differences between skin and muscle temperatures.

Calculations show that the ratio of energy absorption in fat and in skin or muscle changes very little over the whole wavelength range (1-30 cm.) and that from this point of view no particular wavelength is better than others. It is considered that wavelengths in the range 8 to 12 cm. are optimal for therapeutic applications.

(*b*) *Infra-red*

It can be calculated that the half-power-thickness of skin for the radiation from a conventional heat lamp is about 0·45 mm., while for that from a lower temperature source (e.g. electric radiator) it is approximately 0·07 mm. Thus micro-waves of 10 cm. wavelengths are much more penetrating than the infra-red and produce considerably higher deep temperature rises. Fig. 5 shows for comparison the effects of exposing

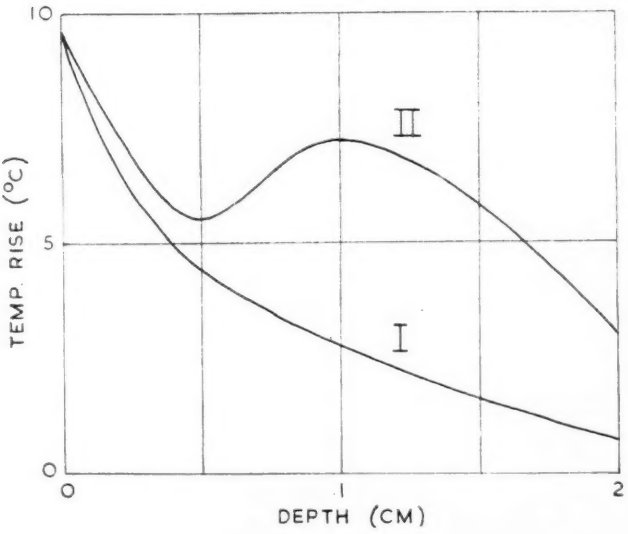

FIG. 5.
Comparison of temperature rises above normal in thigh after 5 min. exposure to micro-waves and infra-red radiation.
Curve I—long infra-red.
Curve II—10 cm. micro-waves.

the human thigh for 5 min. to 1 cal. min.$^{-1}$ cm.$^{-2}$ of long infra-red radiation (electric heater) (Curve I), and to 10 cal. min.$^{-1}$ cm.$^{-2}$ of 10 cm. micro-waves (Curve II). No data are available for radiation from a heat lamp, but the comparable curve for this should lie just above the infra-red curve

shown in the figure. It will be noted that the same skin temperature rise results in both cases, but 10 cm. micro-waves produce higher deep temperatures.

(*c*) *Short-wave currents*

Rae *et al.* (1949) have made a comparative study of the temperatures produced in dogs by 12 cm. micro-waves and short-wave diathermy. Two of their conclusions were: (*a*) there were no significant differences between the temperatures produced in deep tissues by micro-wave radiation and short-wave currents, and (*b*) micro-waves produced a ratio of deep to superficial temperature rise higher than that produced by short-wave currents.

Although these results indicate that micro-waves can produce effects comparable to those of short-wave currents, full consideration leads to the conclusion that short-wave diathermy is still likely to be the method of choice in the treatment of many conditions. If heat production in adipose tissue is to be minimized micro-waves appear to be advantageous.

Possible Dangers of the Use of Micro-waves

Before describing some further experiments on animals, mainly designed to investigate possibly harmful treatment conditions, it will be of value to review the present state of knowledge in this field. Many of the hazards encountered when using micro-waves therapeutically are common to the other well-established thermogenic agents. Under this heading can be mentioned the treatment of regions where the heat dissipating mechanisms of the body are functioning at an abnormally low level. Thus Herrick *et al.* (1950) in a recent review state that micro-waves should be used with caution over ischaemic tissues, and those with subnormal blood supply. In such cases danger arises whenever deep temperatures may exceed those of the skin. This does not occur when using contact applicators, and since skin temperatures can be observed continuously during treatment, treatments are safer under these conditions.

The micro-wave treatment of oedematous tissue, bursae, bullae, etc., is considered dangerous owing to excessively high fluid contents. In fact, the energy absorption of such regions is not very much greater than in normal muscle or skin. The main danger lies again in the possible subnormal dissipation of heat. Thus if the surface tissues still possess normal heat dissipating properties, while the abnormality is localized at a depth, the skin temperature may not then provide sufficient warning of overheating in the affected zone.

Clark (1950) has reviewed work done in collaboration with Hines and others and has pointed out the dangers of micro-wave irradiation of the

eye and testicle, organs in which sensory nerves carrying thermal sensation are deficient. However, it is difficult to foresee conditions of treatment such that surrounding tissues, carrying sensory nerves, would not be heated sufficiently to provide painful warning of overdose. It should also be pointed out that some of the theoretical results reviewed by Clark seem to apply only under treatment conditions unlikely to be approached in the normal therapeutic application of micro-waves.

Metallic foreign bodies present a possible hazard if situated near the irradiated surface. Although they absorb no energy themselves, they may, by re-radiation, cause local temperature rises exceeding a dangerous level with no abnormality shown by the skin temperature. The effect depends on the shape and size of the foreign body in relation to the wavelength of the radiation in the tissues.

Irradiation over bone should be carried out with caution, though experimental results so far indicate no danger. Although inorganic bone is a relatively weak absorber of micro-waves, the absorption in the living soft tissue present in the osteocytes and in the Haversian systems is high. Hence, dangerously high temperatures in these soft tissues may be produced if heat transference from them to low absorbing regions is abnormally low.

Finally, a remote possibility arises of " specific absorption ". In the present case, this term is used to describe direct absorption of micro-wave energy by vital particles or molecules, sufficient to destroy their biological activity. All experiments carried out to date, in which irreversible tissue damage has been produced, can be explained on the basis of heating produced by micro-wave absorption in the extra-cellular and intra-cellular fluids. No evidence has yet been produced for absorption other than by the orientation of water dipoles and by the setting up of ionic conduction currents. Even so it is not impossible that direct absorption by enzymes, viruses, etc., may occur. If present, however, such absorption is likely to be insignificant compared with the absorption in the surrounding medium.

Animal Experiments

Our previous experiments on animals reported the local and general effects of micro-wave irradiation, including the effect of deliberate overdosage. In addition, the effect of a metallic foreign body in the field was studied, and evidence of coagulation necrosis of adjacent muscle obtained (Boyle *et al.*, 1950). It was considered essential to repeat the latter experiment in view of the positive finding, and a further experiment was therefore carried out, using a rabbit, and 10 cm. pulsed micro-waves. Metal plates, size 1 cm. in diameter, were inserted into both the right and left thighs of an anaesthetized rabbit at a depth of 5 mm. A contact

applicator (3·8 × 2·5 cm.) was used for irradiation, and a skin temperature of 44° C. (111·3° F.) achieved over the site of the metal plate in the left thigh. A control area was also irradiated, there being no metal plate beneath the applicator.

Section of the left thigh showed the microscopical changes of inflammatory degeneration and coagulation necrosis of muscle surrounding the metal plate (Plate II). No changes were seen in sections of the irradiated control area, nor surrounding the metal plate in the right thigh. Thus the previous result was confirmed, and the irradiation of regions containing superficial metallic foreign bodies would appear to be contra-indicated. The effect may be due to re-radiation, in which case the shape and size of the foreign body would determine the magnitude of this.

Other experiments have been carried out using the continuous-wave set (wavelength 9·4 cm.), with the object of comparing the effect of irradiation with the applicator at a distance from the skin, as opposed to irradiation with the applicator in contact.

(*a*) The thigh of a rabbit was irradiated to achieve a skin temperature of 45° C. (113° F.), using a 7 cm. circular applicator at 2 cm. from the skin for a duration of 20 minutes. Microscopical section of the irradiated area showed no definite coagulation necrosis of muscle. If it is accepted that irreversible tissue changes result when temperatures in excess of 45° C. are maintained, the result of this experiment suggests that, when air cooling is present, deep temperatures do not exceed appreciably that of the skin. Further work under air-cooling conditions is planned, and a full investigation of temperature gradients is to be made.

(*b*) Experiments were also performed to note the effects of exposure over bone, both under applicator contact, and air-cooling conditions. A deliberate overdosage was given to the plucked thighs of an anaesthetized rabbit, at a point where no muscle was interposed between bone and skin. The left thigh was irradiated with the applicator in contact, and the right thigh at a distance of 2 cm. In both cases the skin temperature was raised to 46° C. (114·8° F.). Sections of the right thigh showed the epidermis to be replaced by acute inflammatory cells, fibrin, and oedema. There were, in addition, vascular changes in the dermis, with coagulation of the vessel walls and obliteration of the lumen. On the left side, the changes were similar, though less marked and of a patchy distribution. Bone changes were absent on both sides.

The result of this experiment suggests that it is not unsafe to apply micro-waves over bony prominences, either in contact or at a distance, provided that the pain threshold is not exceeded, and that the possible bone changes discussed in the previous section are not significant. More work is, however, essential before coming to a firm conclusion on this point.

Summary

1. Further investigations into the thermal effect of micro-waves were carried out in animals and humans, using a continuous-wave set, with a wavelength of 9·4 cm.

2. Skin temperatures were measured during irradiation by a fine wire thermojunction attached to the applicator; the magnetron current was found to be a reliable measure of micro-wave power entering the skin.

3. With power densities below a critical value of 0·8 watts $cm.^{-2}$, the skin temperature was maintained below 47° C. by changes in skin circulation. Pain was felt if this temperature was exceeded.

4. Subcutaneous fat was heated less than underlying muscle since absorption of micro-waves in fat and bone is poor compared with that in skin and muscle.

5. During irradiation, temperatures at depths of 4 cm. from the surface rose steadily, though iso-power curves showed that most of the energy would be absorbed in the first centimetre.

6. The contact method of application was favoured because radiation can then be measured accurately.

7. Animal experiments showed that irradiation of regions containing superficial metallic bodies resulted in tissue necrosis with doses which were normally well tolerated. Application over subcutaneous bone was not found to be harmful.

Acknowledgments

The authors are grateful for the assistance received from others, and in particular to Mr. T. J. Buchanan, who was responsible for the design of the continuous-wave apparatus; to Dr. A. J. Vendrik for invaluable help in some of the theoretical phases of the work; to Professor R. W. Scarff and his staff for histological examinations; and to the General Electric Company for the loan of a continuous-wave magnetron.

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THE AMBULANT TREATMENT OF COMPLICATIONS RESULTING FROM VARICOSE VEINS AND ALLIED CONDITIONS

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VARICOSE veins and other conditions which give rise to hypostatic oedema, although they are not fatal and do not shorten life, are among the commonest causes of inconvenience and incapacity at the present time. It was calculated that in 1937 the number of cases of varicose veins in the United States of America was 1,750,000 or approximately twice that of cancer and three times that of all forms of tuberculosis. The number of days work lost was 5,900,000 (American Rheumatism Association (1949)). Roberts (1949), reports that among some 10,000 applicants for Post Office appointments, the incidence was 28·57 per cent. in women between the ages of 45 and 49 years, and 13·9 per cent. in the age group 35 to 39 years.

The treatment of gross varicose veins is predominantly surgical, but there are many instances in which injection or operation is not possible. In the presence of senility, constitutional disease, arteriosclerosis, or if operation is refused, the only suitable treatment is by support.

R. R. Foote (1951) reported a series of 600 cases treated surgically; of these 127 had ulceration before operation. Of the 600 patients, 55 considered that they were no better and in eight the ulcers remained unhealed. Bauer (1950) reported a series of 196 patients in which 16 per cent. had recurrent symptoms after surgery. From these results it is clear that while the majority of patients with varicose veins can be cured or relieved by surgical measures, a minority is forced to rely on conservative treatment. Although it is only for the minority that conservative treatment is proposed, a large number of patients is concerned.

Payne (1950) states that the consultant sees the most advanced cases and also other people's failures. This is certainly true of the group of patients seen in the Physical Medicine Department of this Hospital, to which most patients are referred when they have suffered from varicose veins, ulcers and eczema for many years. In many instances surgery had failed; in others operation was considered inadvisable. Patients of this type are often resigned to the fact that they will have an ulcer for the rest of their days; that they must endure considerable discomfort, and even submit to periods of rest in bed. They must face loss of time from work and possibly the necessity of giving up their employment. Eczema and ulceration can usually be healed by rest in bed, but recurrence is frequent

soon after the patient gets up. We wish to emphasize that the treatment used in this department is ambulant; that its chief aim is to keep the patient out of bed and in full employment. We believe in the principle that an ulcer healed under ambulant conditions is much less likely to recur.

Aetiology

The generally accepted sequence of events is as follows: venous stasis, oedema, secondary fibrosis, induration and eventually ulceration. The concepts of Bauer (1950) and Anning (1950) are interesting in this connection. General agreement has not yet been reached on the origin of the venous stasis. Congenital weakness or anomalies, together with the constant effect of hydrostatic pressure have been suggested as causes. Phlebosclerosis or thrombophlebitis, followed by recanalization and valve destruction, may be superimposed upon these basic defects. Duguid (1951) has reported that the haemodynamic factor, as opposed to simple hydrostatic pressure, may be of importance. In support of the congenital theory, two-thirds of the patients with varicose veins give a family history.

Method

Treatment is based on the painstaking work of Bisgaard (1948) whose results stimulated the adoption of the method in this department. Its objects are as follows: first, to control the venous stasis and oedema; second, to soften areas of induration; third, to heal the ulcer and restore the health of the surrounding skin. When these objects have been achieved, the position must be maintained by the patient who continues treatment at home by the method which he has learned while attending hospital. This method is based upon a simple triad: bandaging, massage and exercises. They will be described in that order.

External support is essential for the control of venous stasis and oedema. This is achieved by the wearing of carefully applied elastic bandages of adequate strength. Bandages are applied from the distal end of the metatarsals up to the tibial tuberosity. Even pressure is obtained by applying non-absorbent wool padding in the grooves behind the malleoli and at any other point where uneven pressure is likely. If ulceration is present, dressings are applied to the area and these, together with the wool padding, are held in position by a lightly applied cotton bandage. The elastic bandage is then applied evenly, each turn overlapping the previous one by half the width of the bandage.

Massage is of value in the reduction of venous stasis and oedema. For this purpose centripetal massage with the limb in elevation is used, but its effect is only temporary. It is again emphasized that the elastic support is the mainstay in the control of oedema and in the assistance of the venous circulation. Massage is of greater importance when it is used

in the stretching of fibrous tissue, rendering this more pliable. Deep, local friction is, therefore, used about the ulcer base and to other areas of induration. The precise physiological effect of deep frictions is not fully understood at present, but the clinical results are so manifest that great stress is laid upon its use. Cases where bandaging alone has been tried do not show the softening of areas of indurated tissue which is seen in those receiving deep massage. It is interesting to note that the acute local tenderness found in the affected limbs is rapidly relieved by treatment.

The patient is instructed in the performance of exercises to mobilize the joints of the foot and ankle and to strengthen the quadriceps. Exercises are always given with the bandages in position, to reduce venous stasis. The pumping action of the muscles forces the blood from the blood vessels in the area of muscle contraction. Blood is forced along the vessels in the direction of least resistance, namely towards the central circulation, since the elastic support exerts a constant overall pressure on the limb.

To ensure adequate support we have used a bandage which is constructed with 30 longitudinal strands of 44s square-cut natural rubber elastic, with a cotton base. These bandages should be durable, washable, light in weight and not less than 11 feet in length. The bandage described above has proved eminently satisfactory for the control of oedema, but is inclined to be rather heavy and has the disadvantage of being absorbent and, therefore, easily saturated with exudate from the ulcer. We have recently had a special bandage manufactured with the following specifications. Construction: 30 threads 44s square-cut natural rubber; 108 thread warp 60/2 Egyptian gassed, carded cotton; weft, three ends 2/40s spun " Fibro " (an artificial yarn mainly composed of viscose rayon). This type of bandage is approximately 80 per cent. non-absorbent. Tests have shown this bandage to be more durable and to have 30 per cent. greater elongation than that with a cotton base. Preliminary clinical trials indicate that the new bandage is superior to the old. Patients find it lighter, softer and more comfortable. We consider that the ordinary crepe bandage and many of the lighter elastic bandages are totally inadequate.

Faradism is of value as a further method of controlling oedema when there is gross induration in a large limb. Strong, surged, faradic stimulation of the medial and lateral popliteal nerves is given with the elastic webbing bandage in position. The resulting muscular contractions simulate the effect of active exercises. This method is useful where ankylosed joints render the performance of such exercises impossible.

Local treatment of ulceration by dressing is the least important part of the regime. Most authorities agree that the form of local application is immaterial, provided it is not irritant; the dressing used is a matter of personal preference and experience. In this department the basic dressing

is an astringent lotion used by Holger Bisgaard (1948) containing 2·0 per cent. Aluminium Subacetate with 0·6 per cent. Boracic Acid. A bland application such as zinc ointment is used to the area surrounding the ulcer. Where dermatitis is present, calamine lotion or liniment, sometimes with the addition of 2 per cent. Icthyol or ¼ per cent. Argyrol, has been found suitable. It is frequently stated that elastic stockings and bandages are not well tolerated by patients with eczema. It has been our experience that they are well tolerated if the area is dressed with a bland application and covered by a lightly wound cotton bandage before the elastic webbing is applied. If by this method the oedema is well controlled and the skin in a healthy condition before stockings are fitted, they do not tend to irritate the skin nor do they cause a recurrence of eczema.

The use of local E_3 doses of ultra-violet radiation is theoretically of value to sterilize the surface of the ulcer base and promote healing by destruction of superficial tissues with liberation of repair-hormones (Carrell (1921) Hammett *et al.* (1929) and Nutini (1944)). In practice ultra-violet radiation has been found a useful agent in the treatment of grossly infected or indolent ulcers.

The application of sulphonamides or penicillin tends to sterilize the ulcer, but does not of necessity promote healing. Moreover there is the ever-present danger of aggravating the local skin condition and even of causing generalized dermatitis. Antibiotics, if employed, should not be used unless controlled by bacteriological investigation of the ulcer flora, nor for a continuous period of longer than five days. We have treated a controlled series of 20 cases with chloromycetin, aureomycin and streptomycin (2 per cent. in prepared starch) and have observed that while there is a tendency for these preparations to sterilize the ulcer, there is no sign that they promote healing. Control cases often showed a more rapid progress than those treated by the use of antibiotics. There was also the disadvantage that the skin condition was aggravated by these applications in 4 out of the 20 cases. Our conclusion is that the employment of antibiotics is of little value in relation to treatment as a whole. We have now practically ceased to use them.

Indolent ulcers and those with overgranulation may be cauterized with silver nitrate. Healing is also promoted by the application of a Sorbo rubber or felt pad to provide pressure upon the skin edges (R. R. Foote, 1949). The pad is cut to overlap the ulcer edges by approximately half an inch. Pouting of the ulcer edges due to local oedema is an indication for the use of local pressure.

If acute thrombophlebitis occurs as an incident during treatment, the wearing of bandages is maintained unless they cause pain. The patient is instructed to rest the leg and if necessary to remain in bed. Exercises are then stopped and massage is withheld. Massage is cautiously re-introduced as soon as the acute inflammation is subsiding. It is first applied to the

PLATE I.

The illustrations A and C show the right and left ulcers of Mrs. A. S. before treatment and B shows the results obtained.

[face p. 20

PLATE II.

D shows the legs of Mr. J. S. before and E after treatment. Note the reduction of the brawny oedema.

rest of the limb and gradually the area of recent inflammation is approached and finally incorporated.

Patients usually start by attending the department three times weekly. For treatment to be successful the patients must be fully conversant with its objects. They are, therefore, taught to carry out the treatment themselves and this schooling is repeated over and over again throughout their period of attendance. Their attendance is tapered off as soon as satisfactory progress in the state of the limb is observed provided that they can apply the dressings and carry out treatment themselves. Daily treatment is reserved for those with grossly infected ulcers or those unable to perform the treatment themselves for physical or mental reasons. Most patients undertake all their own treatment before healing of the ulcer is complete. During this period they attend for supervision at suitable intervals.

When the ulcer is healed, oedema controlled and the areas of induration rendered pliable, a change can be made from bandages to elastic stockings. The fitting of stockings is a matter of importance. Our usual practice is to fit heavy duty " stout seamless " stockings. Accurate measurements are essential and should be sufficient in number to assure even pressure throughout the length of the stocking.

When deciding whether stockings are to be of the above-knee or below-knee pattern the configuration of the individual limb must be considered. Women wear suspenders and are, therefore, easily fitted with long stockings, but support is always a problem in males. We have found that above-knee stockings are more satisfactory when using the lighter grades of stockings as these tend to slip down if they are fitted below the knee. It is not sufficient merely to approve the fit of the stocking when it is supplied. The patient should be reviewed after wearing it for a month. It is then wise to supply a second pair to allow for washing.

Massage is continued after healing is complete with the object of loosening and at the same time strengthening the skin over the healed ulcer. Before discharge the patients are given a final word of advice. They are encouraged to continue massage and exercises and they are impressed with the necessity of replacing stockings as soon as their elasticity is lost. They are told to report immediately if there is any recurrence of ulceration.

Results

Five hundred and three cases have been treated over a period of four years by the methods described. Seventy-six cases have been transferred elsewhere or were self-discharged. Of the 427 who have been available for continuous observation, 405, of which 53 are still on treatment, were cases of ulceration of the legs and 352 have been healed. The remaining

22 were cases of hypostatic oedema of the legs of which 8 are still on treatment and 14 have been successfully controlled.

Ulcers	405	Still on treatment	53
		Healed	352
Hypostatic Oedema	22	Still on treatment	8
		Controlled	14
Patients transferred or self-discharged	76		
Total	503		

Recurrence rate 12·2 per cent. (42 of 352 healed ulcers)

Complications

Fifteen cases were complicated by arteriosclerosis. Acholuric family jaundice was considered to be the cause of two cases which healed. Six ulcers were considered to be gummatous in origin; in one of these, no anti-specific treatment was given prior to the healing of the ulcer, indicating that local factors were mainly responsible. One case was due to recurrence of ulceration at the site of a tropical ulcer which had completely encircled the leg while the patient was a prisoner-of-war. The application of bandages and the fitting of stockings to patients suffering from arterial deficiency must be approached with caution, but in the main, these are well tolerated and no untoward effects resulted from treatment in this series.

Patients were referred to other hospital departments because of the specific nature of the ulcer, when dermatitis followed healing, or when the condition of the veins or arteries required surgical intervention.

Recurrences

Of 352 ulcer cases which were healed, 42 reported recurrence over the period of four years covered by this series. This is a recurrence rate of 12·2 per cent. In order to test the validity of this overall figure, 100 patients were sent a circular letter asking for a report on their progress. These patients had been discharged for periods of one to three years. Seventy-six replies were received. Of these 9·2 per cent. had recurrence of ulceration and reported for further treatment. We consider that this indicates that our figures give a reasonably accurate reflection of the results obtained in the total series. The results of treatment are similar to those of Bauwens (1949).

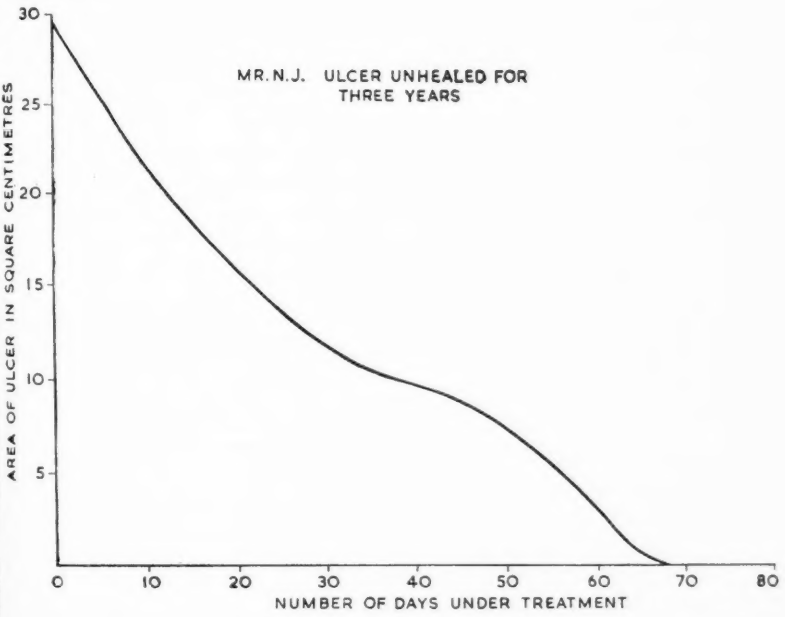
Factors which were found to cause recurrence and to retard healing were the following: (1) Low intelligence, as a result of which the patient was incapable of grasping the principles of treatment. (2) Failure of the patient to continue home treatment. (3) Trauma such as catching the ulcer site on doorsteps, bus-steps, perambulators, and sundry other

domestic hazards. (4) A tendency to generalized dermatitis usually with a history of gross and long-standing varicose eczema. (5) Osteo-arthritis or ankylosis, rendering the performance of exercises difficult or impossible. (6) Inadequate control by stockings of too light a grade. The use of these stockings has now been discontinued. The commonest cause of recurrence was low intelligence; it is usually associated with poor and dirty home conditions.

Experience over the past four years has led to the gradual recognition of these factors. As a result, the routine treatment and instruction of patients has been undergoing modification and our clinical impression is that the results which are now being obtained are better than those of the first year.

Planimetry

It has been the custom in this department to trace the outline of the ulcer on cellophane at intervals during treatment. The area of the ulcer is then obtained by the use of a planimeter. It is recorded graphically by plotting the area in square centimetres against the period on treatment. This method of assessing progress has been found far superior to the simple comparison of direct tracings. The accompanying graph is an example of this method of recording progress in a satisfactory case, the ulcer having been unhealed for three years prior to the beginning of treatment.



Comment

It is recognized that the treatment of varicose veins and allied conditions and their complications is predominantly surgical. Conservative treatment is necessary, however, for all those cases where surgery has failed or is unsuitable. The immense value of an ambulant form of treatment is obvious. The patient can be instructed in the method so that daily out-patient attendance is only necessary in a very few cases and for a limited period.

We do not claim dramatic results for this method and treatment must be continued over many months. We would advocate its adoption as a pre- and post-operative measure and it has been found extremely successful in improving the health of grafted tissue.

This form of treatment is equally suitable for any indolent ulcer of the lower extremity and its use need not be confined to varicose ulcers.

Summary

503 out-patients with chronic hypostatic oedema, induration and ulceration resulting from varicose veins and allied conditions, have been treated in a Physical Medicine Department over a four-year period.

The majority of these cases had failed to respond to surgical and all other forms of treatment over periods up to 30 years.

The treatment employed was ambulant. It was designed to control venous stasis, oedema and induration and to heal eczema and ulceration. The basic methods used were the wearing of elastic webbing bandages to give support, with the local deep friction type of massage to soften areas of fibrosis, and active exercises to promote drainage.

Patients were instructed in the technique of treatment which was then largely carried out at home. Elastic stockings were used to maintain the limb in a healthy condition, after healing.

Of 427 cases under continuous observation, 366 have been discharged cured. Of these the incidence of recurrence was 12·2 per cent. The full results are tabulated and discussed.

The treatment is recommended as a pre- and post-operative regime and for those cases in which surgery is inapplicable or has failed to give relief.

Acknowledgments

We wish to thank Dr. Philippe Bauwens, Physician-in-Charge of the Physical Medicine Department of St. Thomas's Hospital for his continued stimulus and advice in this work. We also wish to thank Miss Audrey Bartholomew M.C.S.P., whose keen interest and valuable co-operation in the supervision of the treatment have been of the greatest assistance to ourselves and of lasting benefit to her patients.

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THE INTERNATIONAL FEDERATION OF PHYSICAL MEDICINE

THE International Federation of Physical Medicine was constituted on May 10th, 1950, at a meeting held in London and attended by representatives from Europe and America. Its aims are as follows: to link existing national and regional societies on an international level; to collect and exchange information; to organize International Congresses at regular intervals. Of these aims the organizing of Congresses is the most important.

Six International Congresses of Physical Medicine have been held since 1905. Of these, the first five were sponsored at irregular intervals by nominated individuals or by national bodies. With the object of promoting international congresses in a more organized way and by a centralized body, the Association Internationale de Médecine Physique et de Physiothérapie was formed at Liège in 1930; it was under its auspices that the Congress was held in London in 1936. As a result of the second world war the activities of the Association Internationale lapsed, so that once again there was no organization for promoting International Congresses.

On the occasion of the International Congress of Medical Electronics held in Brussels in 1948, the opinion was widely expressed that an International Congress of Physical Medicine was overdue and that such a congress should be held in Great Britain. The suggestion was transmitted to the Council of the British Association of Physical Medicine who formed a sub-committee to investigate the situation. The committee reported that in its opinion an international congress should be promoted by an international body, and that such a body should group existing national societies as distinct from individuals. Various national bodies with aims similar to those of the British Association of Physical Medicine were therefore approached with a view to forming an International Federation. Twelve countries nominated representatives empowered to negotiate to this end; they were: Argentina, Australia, Belgium, Denmark, Germany, Great Britain, Holland, Norway, South Africa, Sweden, Switzerland and the United States of America.

At the meeting in London in May, 1950, which has already been referred to, an Interim Committee was set up to act on behalf of the representatives nominated by the national Societies of Physical Medicine until such time as an inaugural meeting could be called to make the structure permanent.

The following were appointed members of this committee:

Dr. Frank Krusen (U.S.A.) *Chairman.*

Dr. Svend Clemmesen (Denmark) *Vice-Chairman.*

International Federation of Physical Medicine

Dr. Hugh Burt (G.B.) — *Hon. Treasurer.*
Dr. P. Bauwens (G.B.) — *Hon. Secretary.*
Dr. W. S. Tegner (G.B.)

Lord Horder joined the committee at a later date.

The offices of the Interim Committee were provisionally set up at 45 Lincoln's Inn Fields, London, W.C.2.

The tasks before the Interim Committee were as follows: to obtain financial security, to obtain increased international recognition, to draw up draft regulations of the International Federation and to promote an International Congress. Financial security was achieved by an anonymous donation, and by contributions from the American Congress of Physical Medicine, the American Society of Physical Medicine, the British Association of Physical Medicine and the Danish Association of Physical Medicine. Increased international recognition was afforded through membership of the Council for the Co-ordination of International Congresses of Medical Sciences, and by the nomination of representatives to the International Committee of recognized associations in Argentina, Australia, Belgium, Denmark, Germany, Great Britain, Holland, Israel, Norway, Switzerland and the United States of America.

Draft regulations outlining the objects and structure of the International Federation for submission to the national delegates next year have been prepared by the Interim Committee, and provisional rules for the management of International Congresses have been laid down. It is in accordance with these rules that the 1952 Congress in London has been planned.

THE BRITISH ASSOCIATION OF PHYSICAL MEDICINE

The Annual Meeting of the British Association of Physical Medicine will be held on Friday and Saturday, April 25th and 26th, 1952.

Friday, April 25th, 1952. Meetings at the Royal Free Hospital.

11.30 a.m.	Discussion on Manipulation. Openers: Dr. E. J. Crisp. Dr. G. D. Kersley. Dr. D. A. Kininmonth.
2 to 4 p.m.	Clinical Meeting.
7.15 for 7.45 p.m.	Annual Dinner at the Royal College of Surgeons.

Saturday, April 26th, 1952. Meetings at the Royal College of Surgeons.

10 a.m.	Annual General Meeting.
11 a.m. to 12.30 p.m.	Short Papers.
2.30 p.m.	Visit to Royal National Orthopaedic Hospital, Stanmore.

THE INTERNATIONAL CONGRESS OF PHYSICAL MEDICINE (1952)

THE International Congress of Physical Medicine (1952) will take place in London from July 14th to the 19th with Lord Horder as president. Though the seventh Congress in this field, it is the first to be held under the auspices of the International Federation of Physical Medicine. Its organization is in the hands of a British Board of Management with Dr. Philippe Bauwens as Chairman of the Executive Committee, Dr. F. D. Howitt as Honorary Treasurer and Dr. A. C. Boyle as Honorary Secretary.

In accordance with the provisional regulations of the International Federation of Physical Medicine, the meetings of the Congress will be devoted to the clinical, remedial, prophylactic and educational aspects of Physical Medicine, and to the diagnostic and therapeutic methods employed in Physical Medicine and Rehabilitation.

The Opening Ceremony is to be performed by Lord Tedder. On the same day, developments in physical medicine in the past decade will be reviewed by authorities from four different countries. The whole of the second day will be devoted to physical education, the third to rehabilitation, the fourth to the management of disorders of the locomotor system and the fifth to electro-diagnostic and therapeutic methods. The scientific part of the Congress will end with papers on the future of Physical Medicine.

The finances required to cover the initial expenses of the Congress have been derived from two chief sources: the treasury of the British Association of Physical Medicine, and the Research Board for the Correlation of Medical Science and Physical Education. A further sum has been obtained from individual members of the British Association of Physical Medicine, who have subscribed generously. More recently there has been a substantial donation from Mr. Bernard Baruch, who is also presenting the presidential badge of office. Finally, the President, Lord Horder, in addition to contributing generously as a member of the British Association of Physical Medicine, is presenting a Ceremonial Lamp, which will be lit at the Opening Ceremony.

Through the offices of the Council for the Co-ordination of International Congresses of Medical Sciences, the Board of Management have been allocated six fellowships to enable young European scientists to attend the Congress. These are being offered to member associations of the International Federation of Physical Medicine.

Details of the Congress appear in the preliminary programme, which can be obtained from the Honorary Secretary, International Congress of Physical Medicine (1952), 45 Lincoln's Inn Fields, London, W.C.2.

ABSTRACTS OF WORLD LITERATURE

Reprinted by kind permission of the editors of *The International Review of Physical Medicine and Rehabilitation*

Consulting Editor: WILLIAM BIERMAN *Editor:* SIDNEY LICHT
Associate Editors: KARL HARPUDER, WILLIAM D. PAUL, WILLIAM BENHAM SNOW

Results of Treatment of Sub-Acromial Bursitis in 340 Cases. GUY A. CADWELL, M.D., and BYRON M. UNKAUF, M.D. *Ann. Surg.*, September, 1950, cxxxix, 432.

Over a seven-year period 485 patients in the Oshsner Clinic were treated for sub-acromial bursitis with procaine injections, X-ray therapy and physical therapy, or physical therapy alone. An analysis of 340 patients three years after beginning of treatment showed satisfactory relief of pain and restoration of useful range of motion in about 80 per cent. of those treated conservatively. In 85 per cent., X-ray therapy relieved the pain produced by tension in the supraspinatus tendon. Physical therapy is reported as a necessary adjunct to any other measures employed and of greatest value when combined with X-ray. Recurrent attacks occurred in 22 per cent. of those with acute or subacute symptoms and 33 per cent. of patients with chronic symptoms.

The authors believe that the presence or absence of calcified deposits is unrelated to the stage of the disease or recurrence. The longer the duration of symptoms before treatment the poorer the prognosis for conservative measures.

We are pleased to note that physical therapy is conceded to be necessary for all patients to maintain and increase joint range; X-ray is effective only against pain and muscle spasm. If motion is restricted following treatment, it is assumed that adhesions are the cause. If the limitation is less than 50 per cent. of normal range and only a few weeks old, a well supervised programme of exercises will be effective. However, when the restriction and duration are greater, operative treatment may become necessary.

This is an excellent discussion of shoulder pain and its management.

Results from the Treatment of 540 Painful Shoulders. PAUL H. HARMON, M.D., GEORGE H. MERRYMAN, M.D., and ELWIN N. NEURU, M.D. *Permanente Found. Med. Bull.*, April, 1950, viii, 60.

Various aspects of shoulder pain due to pathology of the joints, muscles and tendons in the shoulder region are discussed in relation to treatment. Among the physical treatments recommended are manipulation and exercise for periarthritis; and for subacute or acute pain, rest and hot or cold applications.

Intermittent Treatment of Poliomyelitis with Progressive Resistance Exercises. SEDGWICK MEAD, M.D. *J.A.M.A.*, October 7th, 1950, cxliv, 458.

Progressive resistance exercises should begin in poliomyelitis as soon as the patient is out of isolation and sufficiently safe from shortening reactions and

tenderness. Each series of exercises is carried out until the patient reaches a plateau of improvement, then discontinued for a period of from three to four months after which they are resumed until anatomic and physiologic limitations make further muscle hypertrophy impossible. The rationale consists in the attempt to over-train surviving normally innervated muscle fibres to their maximum development. It is shown that this can occur even in an athlete who is presumably using his muscles to capacity.

Contraindications for Physical Medicine in Neurological Conditions. WALTER FREEMAN, M.D., Ph.D. *Arch. Phys. Med.*, October, 1951, xxxi, 653.

Here is a paper to warm the cockles of any inconoclastic heart. The razor-sharp philosophy may make your brain bleed, that is, if there is any blood left in it after enough has gone out to the periphery to fill your blush. Dr. Freeman believes that some physiatrists have such a "healthy optimism and tolerance for frustration" that they sometimes tackle the impossible, hope for a miracle and when it does not occur, let the patient and family down after a great expense. "It would be better to conserve funds for the education and establishment of the children rather than to expend them in a misguided effort to delay the inevitable."

The three neurological conditions in which physical medicine is contra-indicated are paralysis agitans (Their small reserves of energy in the later stages of the disease make the treatment a hardship rather than a benefit), amyotrophic lateral sclerosis ("The hopeful attitude of the patient undergoing physical therapy for an inexorably progressive disease soon gives way to despondency as he observes the withering of the muscles unchecked by treatment") and multiple sclerosis (rest during disease progress is as important as in active tuberculosis).

This is a beautifully written antidote for misplaced over-enthusiasm which should be required reading for all physiatrists and therapists.

New Concepts and Techniques of Neuromuscular Re-education for Paralysis. HERMAN KABAT, M.D. *Permanente Found. Med. Bull.*, July, 1950, viii, 121.

For several years there has been considerable interest in the Kabat method of treating various forms of paralysis. Although visitors have always been welcome to inspect the method at any of the author's centres, publications before this one have been largely theoretical. Here at last is a description of the procedures and their rationale. The rationale is discussed simply and convincingly; whether the clinical application is as effective as the theoretical considerations promise, remains to be seen. Regardless of future validation, this article is very important and should be read by all who work with neurologic patients.

Five treatment techniques are discussed: (1) Maximal resistance increases muscle tension and proprioceptive stimulation and facilitates voluntary motion. (2) Proprioceptive and other reflexes are initiated by stretching or positioning and may activate dormant motion patterns. Examples are the tonic neck reflex, the Von Bechterew reflex and the stretch reflex. (3) Mass movement patterns remain intact in many severe neurologic lesions. Through their use

the author has been able to facilitate voluntary motion and diminish involuntary motion. (4) Reversal of antagonists increases active range of motion and endurance. (5) Rhythmic stabilization is performed by alternating pressures exerted by the therapist against a joint which the patient attempts to maintain in a fixed position. It facilitates voluntary contraction and inhibits spasticity. The article gives specific examples of the five techniques.

Management of Hemiplegics. J. G. PINCOOK, M.D. *Manitoba Med. Rev.*, February, 1950, xxx, 75.

The author discusses four phases of this disease: (1) The acute, which lasts from 24 to 48 hours, in which the treatment is supportive; (2) early recovery, from four to six weeks, in which the muscles are still flaccid. "At this point, and during this phase, the two most important therapies begin: physiotherapy and psychotherapy." (3) Late recovery, up to 18 months, the phase of spasticity, weakness and hypertonicity, and (4) the final phase: "This is one of residual weakness. This is a problem for re-education and reduction of spasticity, but the results are strictly limited. Primarily it consists of accustoming the patient to live with his disability in happiness, and tolerance and to maintain a social living standard comparable with his previous existence."

Experiences with Peripheral Nerve Injuries. EMIL ADLER, M.D., and AHARON J. BELLER, M.D. *Acta Med. Orient*, 1950, ix, 153.

This is a survey of 126 nerve injuries suffered during and after the Palestine War. Tables are presented which show the results of conservative and surgical treatment. A neurological examination and classical electrodiagnosis was done on each patient. A complete physical medicine programme was administered in 56 patients. The results were in accordance with those published in greater volume by observers who managed similar casualties during World War II.

Study of Thermocouples as Skin Thermometers. ALICE M. STOLL and JAMES D. HARDY. *J. appl. Physiol.*, April, 1950, ii, 531.

It is a well-established fact that a radiometer type of heat measuring apparatus is the best to measure skin temperatures. In the present article from the Cornell Physiology Department, the authors have investigated some of the difficulties adherent in the use of thermocouples as skin thermometers. These difficulties are quite considerable. The pressure of the thermocouple against the skin sufficient to produce a stable reading in itself gave an increase in skin temperature sometimes as much as 2° C. The authors found the obvious fact that the thermocouple can heat independently of the underlying skin whenever an outside source of heat, such as radiant heat, is applied. It is well known in Physical Medicine that the same holds true to an even larger extent when diathermy is applied. A bare wire thermocouple is better than adhesive tape covered thermocouple. A 28-gauge wire is better than 40-gauge wire.

The authors concluded that at certain limited conditions the 28-gauge bare wire thermocouple may be used if no greater accuracy than 0·4° is required.

In Physical Medicine one should also be aware of the added difficulty which is not discussed in the present paper that thermocouples are often used to record peripheral blood flow and the difficulties then are far greater than only the

difficulties of the thermocouple itself. This article is very valuable, however, because it adds another criticism to the use of the measurement of skin temperature, namely, the inaccuracy of measuring instrument itself under certain conditions.

L'Examen Thermometrique dans le Diagnostic des Affections Vasculaires Peripheriques. HENRI TYTGAT. *Acta Chir. Belg.*, April, 1950, xlix, 395.

This is a report by Derom and Govaerts of a paper presented by Dr. Tytgat on the value of skin thermometry in peripheral vascular disease. The determination of skin temperature is only of value when associated with certain tests such as those of Landis and Gibbon, and Brown. The author believes that a simple and efficient test is found in the skin response to the intravenous injection of ammonium tetraethylchloride.

The Influence of Physical Therapy Procedures on the Intra Articular Temperature of Normal and Arthritic Subjects. J. L. HOLLANDER and S. M. HORVATH. *Amer. J. Med. Sci.*, November, 1949, ccxviii, 543.

Simultaneous determinations of internal joint and skin temperature were made on 24 normal and arthritic subjects. Passive movement of the joint through its painless range caused little or no change in the joint temperature. In eight cases the mean elevation was on 0·8° F. (0·44° C.). Active weight bearing exercises produced a more marked rise in temperature. Using a Hubbard tank containing water at 101° F. (38·3° C.) for hydrotherapy, there was only slight rise in joint temperature. Radiant heat and the application of paraffin at a temperature of 130° F. (54·4° C.) caused an increase of 3° F. (1·67° C.). The most marked effect was produced by the application of short-wave and micro-wave diathermy which caused rises of 6° to 8° F. (3·3° to 4·4° C.) in the joints. The cooling rate was faster in the normal joint than in the rheumatoid or osteo-arthritic joint. The authors postulated that this may be due to dimunition of circulation and excessive amounts of fibrous and adipose tissues around the arthritic joint. They stress the point that the effectiveness of any treatment should be judged by an increase in intra-articular temperature rather than skin temperature.

The Treatment of Chronic Female Pelvic Sepsis by Short-wave Diathermy. A Review of Fifty Cases. Dr. T. W. BURGESS. *Med. J. Australia*, August 19th, 1950, ii, 285.

The author insists that "this treatment has not yet received much attention. . . . In every case in this series the abdomino-vaginal method was used with a surgical circuit of 'six millimetres' (sic) wavelength." Of 34 patients with pain, 29 were relieved by pelvic diathermy to their own satisfaction.

Clinical Experiences with Micro-wave Diathermy. J. W. RAE, M.D., G. M. MARTIN, M.D., W. J. TREANOR, M.D., and F. H. KRUSEN, M.D. *Proc. Staff Meet. Mayo Clin.*, July, 1950, xxv, 441.

During a two-year period the authors gave 481 patients 4,807 micro-wave diathermy treatments. The duration of each treatment was from 20 to 30 minutes at an output of 60 to 100 watts. Massage and therapeutic exercises

were also used. Three-fourths of the patients treated had shoulder lesions. The results compared favourably with those obtained after other forms of diathermy.

The potential dangers of the method are listed as follows: it is contra-indicated (1) over an area where metallic bodies may be present in the tissues; (2) over an area of ischaemia; (3) over or near the eyes; (4) over markedly oedematous tissue or joints with effusion. It is contra-indicated or used with caution (1) over bony prominences; (2) over epiphyseal region of bones of growing children. The greatest practical limitation to a more extensive clinical use of micro-wave at this time is the limitation of the area which can be treated with the electrodes supplied by the manufacturer.

The advantages are listed as: (1) It provides adequate heating of deeper tissues without undue heating of the skin. (2) The dosage can be measured or controlled more accurately. (3) Simplicity plus flexibility; (4) the directional beam permits localization of the energy for heating limited areas in various patterns; (5) maximal comfort of the patient is provided for in that he can move away from the director at any time; (6) there is less discomfort from perspiration and systemic heating.

It must be remembered that the dosage is regulated entirely by input and not on the amount of energy accepted or absorbed. The fact that the patient's skin temperature does not heat as much as deep tissue may also be a disadvantage. The authors plead a good case for micro-waves, but as can be seen from the list of disadvantages, this form of diathermy still has a very limited use.

Cataract from Infra-red Rays (*Glass Workers Cataract*). *A Preliminary Study on Exposures.* K. L. DUNN. *Arch. Ind. Hyg. Occupat. Med.*, February, 1950, i, 166.

Glass workers cataract (cataract due to infra-red rays) is included in practically every workman's compensation law occupational schedule. In 1908 the British Home Office first published its investigations of infra-red cataracts. This report quoted the work of Robinson, published in 1903, in which he found a high incidence of cataracts in glass workers. They also quote Simeon Snell who could find no higher incidence of cataracts among glass workers than occurred in the general population. Dunn decided to re-investigate the subject. He studied the records of a glass company which had kept accurate histories of all their workers over a 30-year period. This firm produces borosilicate glass, a metal which has a higher melting point than other types of glass. The workers are exposed to an intensity of infra-red varying from 0·2 to 2·4 gm./cal./sq. cm./min. while soft glass workers carrying out the same operations are exposed from 0·1 to 1·2 gm./cal./sq. cm./min. In the borosilicate workers, many of whom had worked at the same job for many years, no cataracts were found. The author summarizes as follows: The experience of one company in which workers have been exposed to extremely intense infra-red radiation for many years resulted in negative results as regards to ocular disturbances. He suggests that it might be advantageous in other trades and exposures to review the earlier works on various occupational diseases with a view to re-evaluating some of the present-day conceptions. This important paper is of interest to "glass

hobbyists " as it describes the various steps in the manufacture of articles of glass.

Dermatitis Solaris Acuta Als Besondere Erscheinungsform Hochgradiger Lichtuberempfindlichkeit. B. ZENNER and J. BEUTNAGEL. *Strahlenther*, 1950, lxxxi, 617.

The skin reaction of normal human skin to sunlight is an erythema caused by ultraviolet rays of medium-wavelength. Only by unduly long exposures can a second degree burn with generalized reaction be obtained. In five patients with hypersensitive skin, a reaction of vesicle and blister formation was observed after a short latent period of only 10 to 40 minutes as against the usual period of several hours. The dermatitis was shown to result from rays of 2980 to 3130 angstroms, but in some cases other wavelengths gave similar results. Elimination of the light stimulus ended the dermatitis and its sequelae.

Experimentelle Untersuchungen Uber den Lichtkrebs. I. Mitteilung. Der Einfluss der Wellenlange des Lichtes Auf Die Enstehung des Lichbrebres Bei der Weissen Maus. W. HELLER. *Strahlenther*, 1950, lxxxi, 387.

To demonstrate the carcinogenic property of ultra-violet light, white mice were exposed to ultra-violet radiations of different wavelengths. The animals were divided into three groups, A received light between 3,200 angstroms, B 3,340 to 2,850 and C 2,800 to below 2,380 angstroms. Three (of six) mice in group A, exposed for more than a year developed no lesion, not even a precancerous lesion. Of 100 mice in group B, only 64 were alive on the 60th day, and only five lived 250 days. In this group, malignant tumours began to appear after 56 exposures given over a period of 149 days. In 32 animals, carcinoma (in some instance multiple) was positively demonstrated; sarcomata were seen in two. In many mice metastases were seen. Radiation with the " middle range " of ultra-violet light was followed by tumour formation in all animals after the sixth month of exposure. The mortality rate for 35 animals in group C was about the same as that for group B, but tumour formation appeared later with the lower wavelengths. Malignant tumours first became apparent after 77 exposures (209 days). Of the 11 animals still alive after the seventh month, ten showed unquestionable carcinomata.

Modern Treatment of Psoriasis. JOHN T. INGRAM, M.D. *Med. Press*, July 5th, 1950, cxii, 5.

Although the " modern " treatment is largely chemical, according to the author, " patients who are intolerant of dithranol—and a true intolerance is exceedingly rare—may be treated with tar paste and ultra-violet light."

Action of Ultra-violet Radiation on Protoplasm. ARTHUR C. GIESE. *Physiol. Rev.*, October, 1950, xxx, 431.

This scholarly review brings up to date, and under one cover, all the recent and some of the older references on the subject. A well indexed table lists the effects of ultra-violet light; bactericidal, fungicidal, viricidal, photolethal, sensitization to heat, cell division, growth, nitrogen metabolism, carbohydrate uptake, fermentation, motility, nerve excitability, permeability of cells, viscosity,

mutation, cancer induction, sunburn, suntan, Vitamin D formation, also therapeutic effects on some skin diseases.

An excellent article for scholars and teachers.

Weitere Erfahrungen Mit Daueriontophorese. J. BARTH. *Ophthalomologica*, July, 1950, cxx, 97.

A total of 46 patients with ulcus serpens were treated with penicillin iontophoresis. In only one was it necessary to inject additional penicillin under the conjunctiva (progressive ulcer). In all other patients progress was stopped following the first session of ion transfer. Regression and visual recovery were very satisfactory. An electrode eye-cup was filled with 10 c.c. of a penicillin solution (2,000 units per c.c.) and secured to the head with an elastic band. The electrode was attached to the negative pole and treatment at about 1 to 2 ma was administered for half-an-hour. Another series of patients with scleritis, keratitis and iritis were given ion transfer with a 2·8 per cent. solution of para-amino-salicylic acid under the negative pole for 15 to 30 minutes at 0·5 to 1·0 ma. Favourable results were seen in all of the 12 patients treated. Trials in cyclitis and periphlebitis were not conclusive. There were no ill effects or complaints.

Ultraschall, Ein Neues Therapeutikum. H. SCHREIBER and W. ECKHARD. *Strahlenther*, 1949, lxxx, 629.

This is a comprehensive report on the Erlangen Congress on Ultra-sound, held in Germany in May, 1949. All of the 75 papers read at the meeting briefly reviewed.

A table containing 48 different indications for ultra-sound therapy is appended to the report. This table is of interest since it was computed from questionnaires given to the congress participants who listed their experiences on a large clinical material.

Is There a Displacement of the Motor Point? DR. J. KOWARSCHIK. *Arch. Phys. Med.*, October, 1950, xxxi, 644.

More than a half-century ago. Wertheim-Salamonson announced that when the peripheral nerve degenerated the motor point of the muscle shifted distally. Electrodiagnosticians have long known this to be a misinterpretation of a clinical finding and Dr. Kowarschik reminds us that the reason for this is physical rather than physiological. A motor point corresponds to the dipping of a motor nerve into the muscle belly. When a motor nerve degenerates there is no nerve and hence no motor point. The exploring electrode will often elicit maximum contraction distally because " at the point of transition of the muscle into its tendon the muscle with all its fibres is traversed by the current." The author also reminds us of another old belief which continues to receive his support. " The salient characteristics of the denervated muscle is the slow, torpid and ' wormlike ' contraction." In our experience this is a late and inconstant finding, so late indeed that electrodiagnosis is seldom requested.

BOOK REVIEW

Recent Advances in Physical Medicine. Edited by FRANCIS BACH, M.A., D.M.(Oxford), D. Phys. Med. London: J. and A. Churchill, Ltd. 1950. Pp. 490. 27s. 6d.

Francis Bach and his thirty-seven contributors have given a comprehensive picture of Physical Medicine to-day. After reading the Editor's preface and the four hundred and eighty-one pages of the book one is left wondering what part the consultant in this specialty has to play in Medicine as a whole. If he is to practice on the broad basis outlined here, can he at the same time be expected to contribute new ideas ? It is interesting to note that contributions of particular excellence are written by men and women who have limited their field, e.g. Bauwens and Richardson on Electrodiagnosis and Mrs. Guthrie Smith on Remedial Exercises.

Some of the subject matter is undoubtedly controversial. Is it, for example, within the sphere of his specialty that the physical medicine consultant should supervise the treatment of septic fingers ? Does the treatment of diseases of the eye, or the skin, or of peripheral vascular disorders really come within his province, even though treatment given may be physical ?

The book is divided into seven sections. It begins with four chapters on physics, anatomy and physiology in their particular application to physical medicine. The second section consists of a number of chapters on diagnostic and therapeutic physical methods. Reference has already been made to the article on electrodiagnosis; in addition there is a chapter by Cyriax on Massage and Manipulation. The chapters in the third section are devoted to the practice of physical medicine in various disease groups. Bach writes on the Rheumatic Diseases, Girdlestone and Crisp on Orthopaedic Conditions. Diseases of the Chest, Peripheral Vascular Diseases, Plastic Surgery, Local Infections, Dermatology, Ophthalmology, Paediatrics and Geriatrics are all fully dealt with. There will be full agreement with Sandifer's remarks on psychiatric problems in physical medicine.

In section five physical medicine in the Army and in Industry are described. In section six there are two excellent chapters; one on Rehabilitation in Industry based on the Vauxhall rehabilitation scheme, and the other on the rehabilitation at Roffey Park of patients suffering from psycho-somatic disorders.

The final section includes a contribution by Kersley on the Training of the Doctor, which will be valuable to anyone contemplating a career in physical medicine.

Apart from one or two spelling mistakes the book is well produced. The photographs and diagrams, though not profuse, have been carefully chosen.

This book should be in the possession of every specialist in physical medicine. It should also prove of interest and value to all practitioners of Medicine.

D. A. KININMONTH.

DR. PHILIPPE BAUWENS

Hon. Secretary 1943-49 Vice-President 1950-